

Thoracic wall reconstruction using both portions of the latissimus dorsi previously divided in the course of posterolateral thoracotomy[☆]

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Abstract

Objective: Besides other factors, the choice of reconstructive method for full thickness thoracic wall defects depends on the morbidity of preceding surgical procedures. The pedicled latissimus dorsi flap is a reliable and safe option for reconstruction of the thorax. A posterolateral thoracotomy, however, results in division of the muscle. Both parts of the muscle can be employed to close full thickness defects of the chest wall. The proximal part can be pedicled on the thoracodorsal vessels or the serratus branch; the distal part can be pedicled on paravertebral or intercostal perforators. This retrospective study was undertaken to evaluate the reconstructive potential of both parts of the latissimus dorsi in thoracic wall reconstruction after posterolateral thoracotomy. **Methods:** Between 1987 and 1999, 36 consecutive patients underwent reconstruction of full-thickness thoracic wall defects with latissimus dorsi-flaps after posterolateral thoracotomies. The defects resulted from infection and open window thoracostomy ($n = 31$), trauma ($n = 3$) and resection of tumours ($n = 2$). The patients' average age was 57 years (range 22–76 years). Twenty-five patients were male, 11 were female. In 31 cases the split latissimus dorsi alone was employed; in five cases additional flaps had to be used due to the size of the defects, additional intrathoracic problems or neighbouring defects. **Results:** In 34 cases defect closure could be achieved without major complications. Empyema recurred in the pleural cavity in one case and one patient died of septicæmia. The 15 patients who had required a respirator in the preoperative phase could be extubated 4.8 days (average) after thoracic wall reconstruction. Postoperative hospital stay averaged 16 days. **Conclusions:** Different methods are available for reconstruction of full thickness defects of the thoracic wall. After posterolateral thoracotomy in the surgical treatment of empyema, oncologic surgery and traumatology, the latissimus dorsi muscle still retains some reconstructive potential. Advantages are low additional donor site morbidity and anatomical reliability. As it is located near the site of the defect, there is no need for additional surgical sites or intraoperative repositioning. In our service, the split latissimus dorsi muscle flap has proven to be a valuable and reliable option in thoracic wall reconstruction. © 2002 Elsevier Science B.V. All rights reserved.

Keywords: Thoracic wall defect; Reconstruction; Latissimus dorsi flap; Thoracotomy

1. Introduction

Besides other factors, the choice of reconstructive method for full thickness thoracic wall defects depends on the morbidity of preceding surgical procedures. The latissimus dorsi flap is reliable and applicable for thoracic wall defects as well as for multiple other indications as a pedicled or free flap [1,2]. A posterolateral thoracotomy, however, results in

division of the muscle, leaving a relatively small proximal portion on its dominant thoracodorsal blood supply. Nevertheless, the latissimus dorsi flap still retains some reconstructive potential as both parts of the muscle can still be employed in closure of lateral and posterolateral full thickness defects of the chest wall after posterolateral thoracotomy. The proximal part can be pedicled on the thoracodorsal vessels or the serratus branch; the distal part can be pedicled on paravertebral or intercostal perforators. This retrospective study was undertaken to evaluate the reconstructive potential of the split latissimus dorsi flap in reconstruction of lateral and posterolateral chest wall defects.

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2. Materials and methods

Between 1987 and 1999, 36 consecutive patients underwent reconstruction of full-thickness thoracic wall defects with latissimus dorsi flaps after posterolateral thoracotomies. Complete in- and outpatient records were available for retrospective evaluation. Follow-up time averaged 42 months (range 3 days–167 months). The defects resulted from infection and open window thoracostomy ($n = 31$), trauma ($n = 3$) and resection of malignant tumours ($n = 2$). The patients' average age was 57 years (range 22–76 years). There were 25 male and 11 female patients. In 31 cases the split latissimus dorsi alone was employed; in five cases additional flaps had to be used due to the size of the defects or additional intrathoracic problems. In four of these cases, a free latissimus dorsi flap from the contralateral

side was employed, and in one case a combined free latissimus dorsi and scapular flap on the same pedicle was used because of a combined thoracic wall and upper arm defect.

2.1. Operative technique (Fig. 1a–d)

The patient is positioned in lateral position with the arm in abduction. After debridement of the wound, skeletal stability is achieved using a synthetic mesh that is sutured into the skeletal defect with non-absorbable sutures if more than three ribs have been resected. The wound is extended proximally and distally. Via the proximal extension, the proximal part of the latissimus dorsi is exposed and its pedicle is visualized. The pedicle is dissected up to the axillary artery. The proximal part of the muscle is usually used for the anterior part of the defect. If it is impossible to

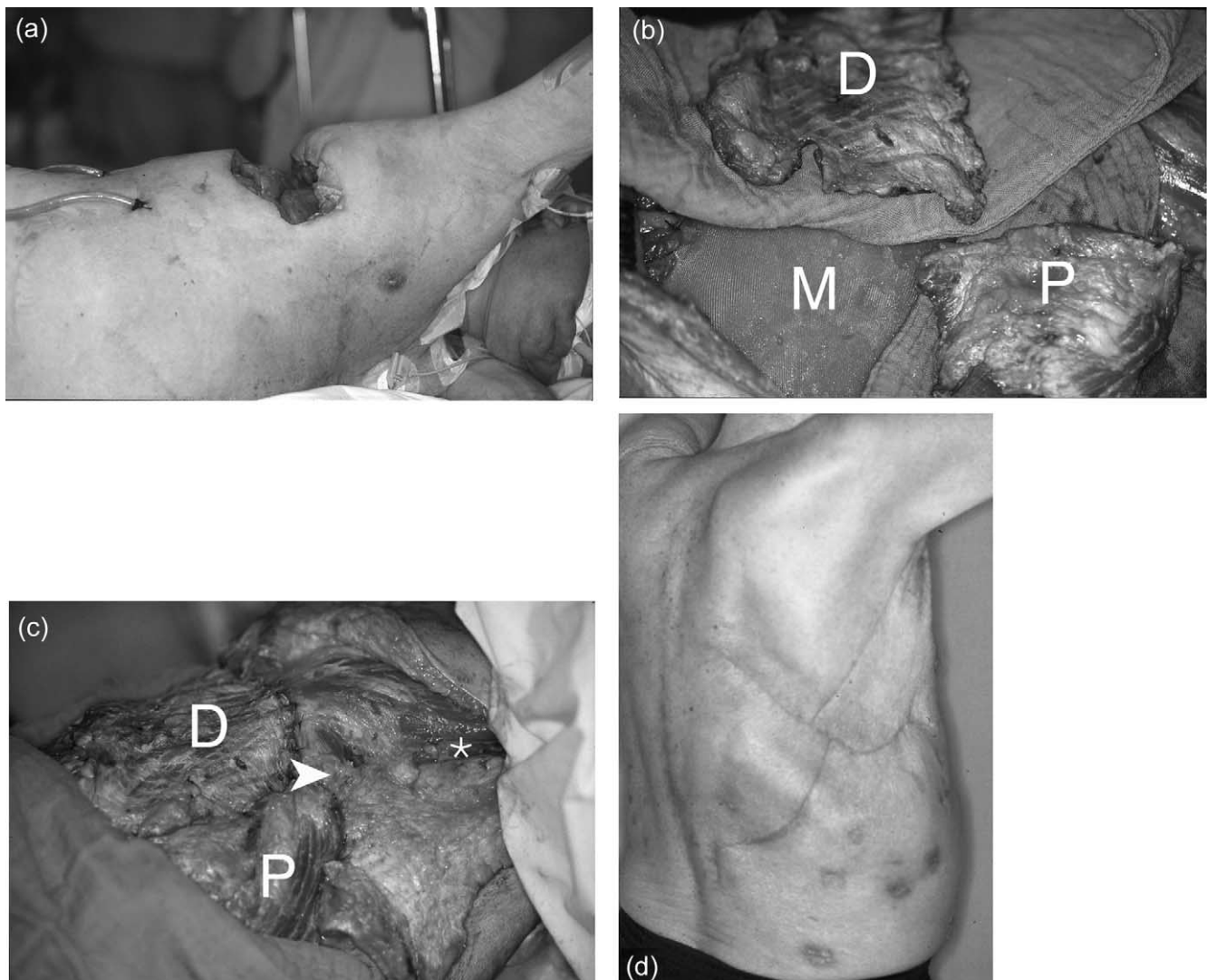


Fig. 1. (a) Defect of the chest wall after open-window thoracostomy for pleural empyema. (b) The skeletal defect has been stabilized with a synthetic mesh (M). The proximal (P) and distal (D) portions of the latissimus dorsi have been harvested. (c) The proximal (P) and the distal (D) portions of the latissimus dorsi have been moved into the defect. The thoracodorsal vessels have been transected (asterisk) proximal to the serratus branch and the proximal part of the flap is pedicled on the serratus branch (arrowhead). (d) Result 8 weeks postoperatively.

transport the flap into the defect pedicled on the thoracodorsal vessels, the serratus branch is dissected, the thoracodorsal pedicle is divided proximal to the serratus branch, and the flap can then be transferred further distally and thus reach the defect pedicled on the serratus branch. The distal part of the muscle is exposed using the distal extension. After dissecting skin and subcutaneous tissue from the muscle, the muscle is mobilized at a submuscular level. Care is taken to preserve at least two major perforating vessels that can be found emerging in the paramedian area or further laterally from the intercostal vessels. The muscle is mobilized completely from its origins in the thoracolumbal fascia, the iliac crest, the caudal ribs and the caudal thoracic vertebrae, and can then be transferred into the dorsal part of the defect pedicled on the perforating vessels. The flaps are secured in their positions and the skin is closed directly after advancement. If direct skin closure over the flaps is impossible, split thickness skin grafts are applied.

3. Results

In 34 cases defect closure was achieved without major complications. There was one recurrence of empyema in the pleural cavity and the thorax had to be reopened. One patient died of septicaemia 3 days after reconstruction of the thoracic wall. Minor complications included wound dehiscence ($n = 4$) requiring secondary suture in two cases and postoperative bleeding necessitating surgical revision in two cases. Fifteen patients required a respirator in the preoperative phase; they could be extubated after an average of 4.8 days (range 2–13 days) following thoracic wall reconstruction. Hospital stay of the patients averaged 26 days (range: 12–102 days). In this context, there were three groups of patients: patients with open window thoracotomies and early closure ($n = 13$; average hospital stay 38 days; range 22–102 days); patients with open window thoracotomies and late closure after treatment as outpatients ($n = 18$; average hospital stay 20 days; range 17–32 days); patients with closure of defects after tumour resection or trauma ($n = 5$; average hospital stay 18 days; range 12–36 days). In the early-closure group the interval from thoracotomy to flap closure averaged 22 days (range 9–51 days); in the late-closure group it was 15 months (range 7–23 months). Hospital stay after reconstruction averaged 16 days (range 12–59 days). Thus, in the majority of patients rapid closure could be achieved, resulting in shortened hospital stay and prompt psychosocial rehabilitation. After a follow-up of 42 months (average; range 3 days–167 months), 23 patients are alive. Two patients died due to metastatic spread of their causative malignant disease 5 and 7 months, respectively, after reconstruction. As mentioned above, one patient died due to septicaemia on the third postoperative day. Ten patients died to unrelated causes.

4. Discussion

The goals of reconstruction of chest wall defects are restoration of integrity of the integument, stability of the skeletal thorax, control of infection and finally psychosocial rehabilitation. There are several methods to reach these goals including secondary healing after open window thoracostomy and defect closure with flaps. Secondary healing takes time and subjects the patient to a high degree of physical and psychological stress. Furthermore, there is a risk of superinfection of the wound and of suture lines or prosthetic materials and a poor result in terms of appearance and chest wall stability is to be expected [3].

The popularization of myocutaneous flaps has made the reconstruction of thoracic wall defects a common procedure. Large chest wall defects can now be covered by a variety of anatomically secure flaps. These flaps include pedicled flaps from the thoracic wall itself such as the latissimus dorsi flap, the serratus anterior flap or the pectoralis major flap. Pedicled flaps harvested from the abdomen such as the different varieties of rectus abdominis or omental flap have also been used routinely in thoracic wall reconstruction [1,4,5]. Of course, microvascular free flaps can also be applied in reconstruction of the thoracic wall. This method is preferably used in very large defects; thus, large free flaps such as the latissimus dorsi from the contralateral side, the free transverse rectus abdominis flap or the tensor fasciae latae flap belong to the reconstructive surgeon's repertoire for chest wall reconstruction.

Which method is chosen for a specific defect depends on several factors. These involve patient-related factors such as nature and location of the defect and the patient's general condition. Furthermore, flap-associated factors influence the choice of reconstructive method. Severe additional donor site morbidity should be avoided and the selected technique should not preclude future options for surgical procedures [4]. Obviously, the morbidity of preceding surgical interventions also has an impact on the choice of reconstructive method.

Arnold et al. have used the serratus anterior flap extensively in intrathoracic and extrathoracic reconstruction [6]. They stated that defects up to the size of a hand can be covered with the serratus anterior flap. As the distal part of the muscle is often sacrificed when an open window thoracostomy is performed in the posterolateral aspect of the thoracic wall, only the proximal part of the muscle is available for reconstruction. This part could be used for moderately sized defects, but not to cover a complete open window thoracostomy or a large defect after tumour resection or trauma. Thus, the serratus muscle instead of the proximal part of the latissimus dorsi muscle could be used to close the anterior part of the defect. If the proximal part of the serratus anterior is used in reconstruction, it must also be completely dissected from its scapular attachment. This in turn often leads to winging of the scapula [6] and subsequently to significant impairment of shoulder function, pain

and cosmetic deformity of the shoulder girdle [7,8]. As the latissimus dorsi muscle is already divided and so has lost its function at that stage, the use of its proximal part holds the advantage of not producing additional donor site morbidity.

The pedicled pectoralis major flap is routinely used in thoracic wall reconstruction. It is very well suited to close small to moderate sized defects of the anterior part of the thoracic wall, especially around the sternum [1]. Large defects and defects on the lateral or posterolateral aspect of the thorax, however, cannot be covered with this flap. Furthermore, there is significant donor site morbidity after elevation of this flap such as weakness of the shoulder girdle and absence of the anterior axillary fold, which is a major cosmetic deformity.

The various flaps based on the rectus abdominis muscle can be applied to large defects of the thoracic wall as pedicled or free flaps [4]. The pedicled rectus abdominis flap is anatomically secure even after the internal mammary artery has been severed [9]. It can provide large amounts of well vascularized tissue and the lateral and posterolateral portion of the thorax can be accessed very well [1]. This flap does, however, entail important disadvantages. Bulging of the abdominal wall [10] and abdominal hernias [11] often occur after this flap has been harvested. In addition, the patient must be repositioned during surgery if defects on the posterolateral aspect of the chest have to be covered, increasing the duration of surgery. Moreover, an additional large wound is created which in turn means greater stress to patients who are usually in a poor general condition.

The omentum as a flap harvested from the peritoneal cavity is routinely used for thoracic wall and intrathoracic reconstruction [5]. It is very well suited for desobliteration of dead spaces and infection control [5]. In the series of 60 cases reported by Hultman et al. [5], however, abdominal wound infections occurred in 10% and epigastric hernias in 11.7%. Thus, there is significant donor site morbidity when this flap is used. Furthermore, laparotomy is necessary to harvest this flap and the patient has to be repositioned intraoperatively to achieve closure of defects on the posterolateral aspect of the chest. These two factors impose additional stress on these often critically ill patients.

Free flaps amenable to the reconstruction of large thoracic wall defects include the contralateral latissimus dorsi, the transverse rectus abdominis and the tensor fasciae latae [4,12]. As stated above, intraoperative repositioning of the patient lengthens operating time significantly. Repositioning is necessary in the coverage of posterolateral chest wall defects if the contralateral latissimus dorsi or a free transverse rectus abdominis flap is used. This drawback does not account for the free tensor fasciae latae flap as it can be harvested in a lateral position. Donor site morbidity, however, is significant with this flap [13,14]. Microsurgical procedures are more time-consuming than pedicled flaps and there is a risk of complications with microsurgical anastomoses. Thus, as a variety of pedicled flaps are suitable for thoracic wall reconstruction even in large defects, free

flaps are only used in selected cases that require a very large amount of tissue that cannot be supplied by pedicled flaps alone, e.g. with a postpneumectomy empyema cavity that has to be obliterated or an insufficient bronchial stump. In this series, free flaps had to be used additionally in five cases. In four cases, a postpneumectomy empyema cavity was not considered clean enough to close the wound without obliteration of dead space; in two of these cases there were insufficient bronchial stumps that had to be closed with muscle. In one case an additional defect on the arm had to be covered and a combined contralateral free latissimus dorsi–scapular flap on the same pedicle was chosen to cover the thoracic wall and the upper arm defects simultaneously.

Timing of reconstruction is an important issue in the closure of thoracic wall defects. In those patients with defects that resulted from trauma or tumour resection, closure was done as early as possible, i.e. in a one-stage operation in all three of the oncologic patients in this series and on the third and fourth days, respectively, in the two trauma patients. As far as open window thoracostomy is concerned, it must be said that, in our institution, open window thoracostomy is performed as an emergency procedure in critically ill patients and when the thoracic window is created, the primary goal is to save the patient's life. As soon as this goal has been reached, reconstruction is an option and if the following conditions are fulfilled, it is performed: (a) suitable general condition of patient, (b) infection control in the pleural cavity, (c) patient's wish and informed consent. To our mind, every patient in suitable general condition with a thoracic window should be offered reconstruction. It was mentioned above that secondary healing is time-consuming and the results in terms of appearance and chest wall stability are poor. There were no distinct criteria for the degree of infection control that allows closure in this series. The thoracic and the reconstructive surgeons decided this together on the basis of their experience. If it was felt that the wound was not clean enough, closure could still be achieved if dead spaces were obliterated with well-vascularized tissue; this was done in four of the cases in this series using additional muscle flaps. In two of these cases non-patent bronchial stumps were sealed with muscle flaps. Thus, the presence of a fistula does not preclude closure of the thoracic window.

There is of course a certain degree of atrophy of the distal portion after division of the muscle. This atrophy primarily affects muscle thickness. Perfusion and the area that can be covered with the distal part, however, are not affected. This is very well illustrated by the cases with late closure in this series.

The latissimus dorsi flap is routinely used as a pedicled flap in reconstruction of chest wall defects [2]. Our experience in this series shows that, in comparison to the alternatives mentioned above, the latissimus dorsi muscle holds important advantages in closure of large defects on the lateral and posterolateral aspect of the chest wall after a

posterolateral thoracotomy. The latissimus dorsi has a dual blood supply [9]. The thoracodorsal artery, a branch of the supscapular artery, is the dominant vessel entering the proximal part of the muscle approximately 10 cm from its origin. The muscle is also nourished by segmental perforating vessels coming from the intercostal and lumbar arteries. Our results show that based on this vascular anatomy, both the proximal and the distal parts of the muscle can be used safely for reconstruction of the chest wall. It must, however, be said that the surgeon employing this technique should be skilled in the use of muscle flaps and especially in the use of the latissimus dorsi flap pedicled on segmental perforating vessels. Thus, the reconstruction should be an interdisciplinary procedure involving a plastic surgeon, unless the thoracic surgeon has special skill in the use of the latissimus dorsi flap.

Although functional examination was not part of this study it is obvious that, as the muscle has been divided in the course of the thoracotomy and thus has already lost its function, no additional functional donor site morbidity is created when it is employed in thoracic wall reconstruction. No intraoperative repositioning is necessary and the flap is harvested from a region in close proximity to the defect. This means a relatively short operating time with less stress to the patient. Thus, even after posterolateral thoracotomy the use of both parts of the latissimus dorsi flap is a safe and valuable option in reconstruction of lateral and posterolateral chest wall defects, and thus can be encouraged for this purpose.

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Appendix A. Conference discussion

Dr C. Gebitekin (Bursa, Turkey): Could you clarify a couple of things I am a bit confused about. First of all, What was the reason of infection on the chest wall? Secondly, why did you do two incisions, because if you do the first incision for a latissimus dorsi, it is enough for a thoracotomy? Also, where were the defects you have reconstructed?

Dr Tomaselli: I understand the last part of the question. The localization of the defect was sited at the posterolateral thoracotomy. So I have seen it in the last 5 years, because this goes back to the 1980s, the posterior localization of the defect.

And the other two parts of your question I did not get a chance to understand.

Dr Gebitekin: What was the reason for chest wall infection?

Dr Tomaselli: For chest wall infection followed by the defect?

Dr Gebitekin: No.

Dr Tomaselli: No? Sorry. The reason for chest wall infections was empyema.

Dr Gebitekin: Empyema?

Dr Tomaselli: Yes.

Dr J.-F. Velly (Bordeaux, France): In a case of entire empyema of the pleural cavity are you able to fill it with the split latissimus dorsi?

Dr Tomaselli: No. In these cases I can observe what has been done with this technique over the last 5 years, and in the case of empyema, if the thoracic wall is infiltrated or destroyed by this perforating or penetrating empyema, we have to resect a little part of the wall, and this results in a defect of the wall with this open thoracostomy, and those defects are then closed with a split, because the conventional method of empyema surgery for us is a posterolateral thoracotomy, and those defects are closed by the split latissimus dorsi.

Dr T. Grodzki (Szczecin, Poland): What you describe is in fact a Clagett procedure, and then if I understood clearly, you are working to close the defect, but the rules are to fill all remaining cavity with muscle, not just to close the window.

Dr Tomaselli: But if you have empyema surgery, you will have to put the lung in there, so there is not a hole. The only defect was localized at the thoracic wall, if I understand your question right. So you had the defect of the thoracic wall, and the cavity is filled up with lung, with decorticated lung.

Dr Grodzki: That clarifies it for us.

Dr Tomaselli: You have to perform the defect closure of the thoracic wall. So in cooperation with our friends in reconstructive surgery, we can reach skeletal stability by using this mesh, and we work together, and it is for us a rather easy and rather practical procedure using this in situ latissimus. It is split, yes, of course, but you can use it to cover the mesh and to mobilize the soft tissue, and if you have slight defects of the skin, you can get skin wherever you want. So the cavity is filled up.